MAJOR PROJECT PROGRAM COST ESTIMATING GUIDANCE
June 8, 2004

INTRODUCTION

Estimates are central to establishing the basis for key project decisions, for establishing the metrics against which project success will be measured and for communicating the status of a project at any given point in time. Logical and reasonable cost estimates are necessary in maintaining public confidence and trust throughout the life of a major project. Cost increases over and above the early planning and environmental estimates for major transportation projects have become an increasing concern to Congressional and political leaders, Federal and State top managements, and auditing agencies.

This guidance is for the preparation of a total program cost estimate for a major project. For the purpose of this guidance, a major project is defined as a project that receives any amount of Federal financial assistance and has an estimated total program cost greater than $1 billion (expressed in year-of-expenditure dollars), or has an estimated total cost approaching $1 billion with a high level of public or Congressional intent. The total program cost estimate includes construction, engineering, and related costs, which will be identified by this guidance. Although this guidance is for major projects, it may also be applied to other projects.

Major projects by nature are usually more complex and contain more risk elements than other projects. Careful attention must be provided when preparing cost estimates for major projects. Traditional estimating methods may not be appropriate in all cases. This guidance is intended to assist State transportation departments, the FHWA, and other sponsoring agencies with ensuring that all program cost estimates are prepared using sound practices that result in logical and realistic initial estimated costs of the projects, providing a more stable cost estimate throughout the project continuum.

KEY PRINCIPLES

In general, there are key principles that should be adhered to when preparing a program cost estimate at any stage of a major project. The estimated cost of a project is one of the most important metrics against which the success of the project will be measured. It is important that care is taken to present an achievable estimate even in the early stages of project development.

Integrity: A high standard of ethical integrity is a must. Cost estimates must be calculated through an open or transparent process. Any uncertainties should be explained in an easily understood manner in laymen's terms. Avoiding false precision and early optimism will go a long way in maintaining the public's trust, support and confidence in the project and will result in a more stable statewide program. The use of consultants to prepare estimates on major projects must be carefully structured and reviewed, to make sure that no conflicts of interest exist from a Government-Contractor relationship aspect. The contracting agency should have procedures that address conflict of interest issues in all solicitations for engineering services.

Contents of a Cost Estimate: The cost of a project is most often interpreted and most easily understood by the public to be dollars that are spent on the project. The program cost estimate should be considered the equivalent of the total project purchase price. As such, the program cost estimate should include all costs and the value of any resources needed to complete the design, right-of-way activities, environmental mitigation, construction, project management, etc. as well as costs and resources paid to others for work related to the project such as utility adjustments, environmental mitigations, and railroad relocations. The program cost estimate should not include the costs of acquiring revenue (taxation, mortgage interest payments, etc. - see DOT Order 4600.17A for guidance on the inclusion of interest payments). All costs should be calculated in accordance with state-of-the-practice accounting methods.

Year-of-Expenditure Dollars: After the cost estimate is prepared, it should be expressed in year-of-expenditure dollars if there are multiple construction contracts. This can be done by assigning an inflation rate per year to the proposed midpoint of construction, with some allowance for schedule slippage taken into account. Make certain that the selected year-of-expenditure reflects a realistic scenario, taking into account project planning and development durations, as well as construction. Potential schedule slippages can also be accounted for in a project contingency. Clearly specify how inflation is considered in the estimate and clearly state that the estimate is expressed in year-of-expenditure dollars. Consider multiple sources for determining the inflation rate, including nationwide and local references. Include consideration of any locality-specific cost factors that may reflect a growth rate significantly in excess of the inflation rate, such as land acquisition costs in highly active markets. Reporting the costs in year-of-expenditure dollars will greatly reduce the media and public perception of cost growth.

Basis of a Cost Estimate: Estimates should be developed using the best information available. When preparing any estimate, engineering judgment must be applied. For example, bid based estimating is only good if the historic prices are for similar work and similar sized projects. Engineering judgment must also be applied to any assumption made.

It is important to also consider how projects will be funded. Some major projects may be completely funded when construction begins. Others may have limited funding or be funded in phases (e.g. corridors). This will certainly affect the costs due to inflation and may result in a wide range of costs.

Risk and Uncertainty: Costs should be attached to uncertainties within an estimate. All elements of the project must be reduced to a cost that can be accounted and budgeted. There should be a disciplined and comprehensive method of assessing and reassessing project risk and uncertainty. Costs that are unknown and costs associated with potential risks can be included in the form of a contingency amount. Major projects require special consideration of project risk and complexity in order to produce accurate contingencies. Contingency estimates should be defined and quantified throughout the project's development as specific risk elements, which then can be used to create a risk management plan for the project. As the project is refined, the contingency should reflect the shift of contingencies into actual cost categories. Contingencies should be expressed in terms that can be easily presented to and understood by the public. The appearance of

false precision must be avoided. Unsupported early optimism (i.e. low contingency amounts) will only cause problems as the project progresses. In some cases, a range may be appropriate for program cost estimates. A risk analysis also provides a collateral benefit of focusing project risk management activities.

Project Delivery Phase Transitions: Estimates should be tracked throughout the life of the project and assumptions and estimate information must be well documented, including changes and what is and what is not in the estimate. The estimate should note which phase of the project is being estimated (e.g. Feasibility Study, NEPA, Preliminary Engineering, Final Design, Construction). The documentation should be in a form that can be understood, checked and verified. In addition, cost estimates should be tracked and evaluated throughout each phase of the project. To facilitate tracking projects, it is important to use the same project identification throughout. When cost estimates constantly increase over time, specific steps should be taken to identify problems and revise cost estimating procedures, as appropriate.

Team of Experts: A skilled, interdisciplinary team should produce estimates. Estimates should be developed using a clearly identified scope of work. Estimates should be based on consultation and input from agency experts and not be developed in a vacuum. For example, right-of-way acquisition costs should be determined in consultation with an agency's right-of-way office. Field reviews should be taken prior to preparing any estimate. For work that is unusual, (e.g. buildings, railroads, mass transit, ferry boat docks, etc.) consultation with outside agencies may be appropriate.

The estimating team should be composed of experienced personnel, with the requisite technical, managerial, leadership, and communication cost estimating skills. The team should also have a thorough understanding of the project's scope, including the ability to determine and evaluate critical issues and risks. If resources are available, others experienced in estimating who have not been extensively exposed to the project should also provide input. This can bring a new independent analysis regarding items that may have a major impact on the cost estimate. Core competencies for cost estimating and a formalized training program to meet these competencies should be established. In addition, an estimating process manual should be in place. Some State Departments of Transportations already have comprehensive cost estimating manuals and procedures. An experienced person who is well trained in major project estimating should lead the process.

Validation of Estimates: A competent disinterested party should validate the cost estimates. Estimates on very large projects are very complex and subject to perceptions of being inappropriately manipulated. A second independent set of eyes to review the estimate will afford managers and decision makers an opportunity to capture a different perspective or at least a second opinion.

Revalidation of Estimates: Periodic reviews of estimates are important for several reasons. First, conditions and underlying assumptions for original and subsequent estimates often change, thus estimates need to be refreshed to account for these changes. Second, throughout project development phases there are key decisions in the public interest that must be made based upon the most current and accurate estimates possible.

Finally, it is also that management must have a means of minimizing the potential for unanticipated surprises concerning the financial condition of the project.

Release of Estimates and Estimating Information: Careful consideration must be given to the context surrounding the release and potential use for the information provided in the estimates. While estimates may have been developed for a specific and unique purpose they may be subject to misuse by those who do not understand the applicable context. Cost estimates should not be released to the public or be the basis for project approval until they have been thoroughly reviewed and found to be consistent with the project scope and are accurate and complete indicators of project costs.

PROGRAM COST ESTIMATE ELEMENTS

The following cost elements should be included when preparing a program cost estimate for a major project:

Preliminary Engineering. This is the cost to prepare the construction documents. It includes any field investigation, testing and administration of the design work. It also includes the cost of the NEPA and other environmental documentation. The cost of a General Engineering Consultant for this work would be included here.

Right-of-Way. This is the cost to research and acquire right-of-way for the project, including easements. Include right-of-way costs for storm water management, wetland mitigation, and other work outside the roadway prism. This includes the contractual obligations with property owners to relocate fencing, reconstruct gates, reconstruct road approaches, etc., if not included in the engineer's estimate. This also includes the cost of any required relocation of residents and businesses, as well as the administration costs of right-of-way activities. If the extent of the right-of-way acquisition is not known, then a contingency should be added based upon historical settlements and awards for condemnation cases, which must include costs for attorneys, engineering research, witness research, survey, and staff time. Also, the right-of-way acquisition schedule needs to be considered. Right-of-way acquisition costs will increase quickly in rapidly developing areas. Early acquisition of right of way based on environmental documents may save money and protect the right-of-way from development. Costs must include relocation assistance and benefits for displaced individuals, families, businesses, governments, and nonprofit organizations. Special acquisitions, such as those from government sites can be time consuming and costly. Note that the user of right-of-way estimates always must recognize that the estimates are very dependent upon the accuracy and reliability of information concerning the location of the right-of-way limits on a project. A very small change in the location of the right-of-way line, or a change in access control or drainage retention placement, particularly in commercial areas, can affect the right-of-way cost estimate by many millions of dollars because of required damage payments such as severance or business damages.

External Third Party (e.g. Utilities and Railroad Adjustments). Perhaps the most difficult costs to estimate are those that are associated with third parties, such as utilities and railroads. Third party requirements have a high potential for risk and change. For example, major projects often are located in urban areas with a high concentration of

existing utilities. While it is best to locate and avoid as many utilities as possible during the design phase, appropriate contingencies for utility adjustments need to be included. Cost should be included for subsurface utility engineering. Mitigating impacts to railroads or transit lines will need to be considered as well. If all utility and railroad adjustment work cannot be identified, appropriate contingencies for adjustments need to be included.

Transportation Demand Management and Transportation System Management. The program cost estimate should include the costs for the development and implementation of the transportation demand management and transportation system management strategies along the construction corridor and in the communities in the vicinity of the project during the construction period that are related to the project.

Construction Estimate. This construction estimate is the cost of physically constructing the project in the time required based on current costs for labor, materials, equipment, mobilization, bonds, and profit. The following should be considered when preparing the construction cost estimate:

Contracting Method. Innovative contracting techniques such as Design-Build, cost-plus-time bidding, lane rental, etc. should be taken into consideration when preparing the estimate. Design-Build contracts and contracts with performance-based specifications or warranties impose a higher risk on the Contractor and may increase a Contractor's bid. Any stipend costs should be included in the estimate.

Acquisition Strategy Analysis. A separate Value Analysis on the project should be considered to determine the most economical and advantageous way of packaging the contracts for advertisement. A Value Analysis is a systematic approach by a multi-disciplined team to identify functions of a project, establish a worth for each function, and generate alternatives that satisfy each function at the lowest life-cycle cost.

Surety Issues. Obtaining bid and performance bonds for major projects are difficult, especially for smaller contractors. If bonding requirements are not reduced, then an increased amount for obtaining bonds should be included in the cost estimate.

Bidding Climate Impact. Cost estimates should consider the economic impact of the major project on the local geographical area. For example, material manufacturers that would normally compete with one another may need to combine resources in order to meet the demand of the major project. Extremely large construction packages also have the potential to reduce the number of contractors that have the capacity or capability to do the work, and may need to be split up into smaller contracts to attract additional competition. Cost estimates should take into account market conditions. If the economy is experiencing a downturn and there is more competition for projects, contractors will bid with less profit. Conversely, if the market is healthy and more projects are advertised, contractors will bid projects with higher markups. In addition, the timing of the bid solicitations can also have an affect on the cost since contractors may be more

competitive during the winter months when trying to build some inventory. Cost estimates should also consider controls on the use of labor.

Industry Capacity. The number of potential qualified contractors that are able to bid on major projects are limited to those that have the capacity to construct the project. Contractors who bid on major projects often bid on projects throughout the country. If other major projects are being advertised concurrently, this may have a limiting effect of competition and would result in higher bids. If possible, rescheduling advertisement dates may be appropriate.

Highly Specialized Designs and Technology. Cost estimates should consider the impact of any requirement to use first-of-a-kind technology, new materials, or methods of construction.

Context Sensitive Solutions. The implementation of context sensitive solutions into a major project may have an impact on the program cost estimate.

Construction Time. The impacts of construction activities (e.g. sequencing, traffic control, haul routes, accessibility, geographic locations, repair work to roads damaged by construction equipment, and for ponds that may be silted as part of construction) should be considered when developing cost estimates. Also, costs associated with rush hour restrictions and night work must be considered.

Construction Incentives. The cost for the contractor to meet quality/material and performance incentives must be included in the cost estimate.

Construction Contingencies. To allow for the likelihood that additional construction work will be identified after the design has been completed and the project awarded, a contingency for cost growth during construction should be included. This is normally around 5 to 10%. However, some projects where the potential for scope creep and changes during construction is high have used a contingency factor approaching 15%. The following may also have an impact on this percentage:

Design-Build Contracts. Design-Build contracting on major projects has thus far shown very little increase from the negotiated contract amount to the final project completion and therefore may require a smaller construction contingency since the number of construction claims due to design errors is substantially reduced.

Number of Concurrent Contracts and Contract Interfaces. On projects where multiple construction contracts are underway at the same time, close coordination of construction activities and schedules may be required. The potential for one contractor to impact another contractor's activities is higher and may result in additional delay or coordination costs during construction.

Contractor Proposed Construction Changes. Construction contracts should include specifications to allow the contractor to propose construction changes that result in benefits to the contractor and the owner. These are sometimes referred to as Value Engineering Change Proposals. Contracts that restrict the opportunity

for contractors to make changes may limit the ability to contain costs once construction starts. An increased construction contingency may be appropriate in these situations.

Construction Time. For longer duration projects, there is a greater risk for impacts to the construction schedule and therefore, the contingency amount should be higher. Construction scheduled in winter or rainy seasons should be accounted for appropriately in the contingency amount, since there may be a higher risk in meeting construction schedules due to unforeseen weather delays. When a major project consists of two phases by different Contractors that are interdependent, a higher than normal contingency may be necessary. Also, compressed or accelerated construction schedules could potentially increase costs.

Protection of the Traveling Public. Major projects often have complex construction traffic control and may have multiple construction contracts underway at the same time. This results in a potential for unanticipated costs once construction begins. Costs may also include incident management, public information and communication efforts, transit demand management and improvements to the local area network, which help improve safety and traffic flow through the project during construction.

Environmental Impacts. Major projects often go through a thorough NEPA process. This will lead to greater public and resources agency scrutiny during construction. As a result, environmental related work may be added during construction.

Other Factors. A few of the potential impacts to the construction contingency are the risks of encountering underground utilities and other obstructions, differing site conditions, contaminated soil, multi-agency involvement, etc.

Construction Administration. This includes construction engineering and administrative oversight during construction. The cost of a General Engineering Consultant for this work would be included here.

Public Outreach. Any costs incurred by the agency with respect to public outreach should be prepared and documented as part of the project's costs. Motorist information plans can be very extensive (and of long duration) on major projects as well as the related costs for publications and news releases.

Management Reserve. A management reserve may be appropriate for high risk projects and projects that are sensitive to changing politics and management. A management reserve is beneficial if significant consequences could result from the project being underestimated.

INTEGRATION OF PROGRAM COST ESTIMATES THROUGHOUT THE PROJECT CONTINUUM

It is recognized that during the planning and programming phases, not as much information is available as is during the final design phase. However, important project decisions are made and public expectations are set at this time. Estimates must be complete and adequate to support these decisions and expectations. Estimates must be prepared in an integrated process throughout the project's development. The program cost estimate prepared during the initial stage should be documented and that estimate should be carried through the project continuum with appropriate adjustments. This section is intended to provide guidance regarding estimating issues prior to completing detailed design.

When developing the program cost estimate at the planning and programming stages, the following should be considered:

Continual Documentation: Cost estimates from the beginning to the end of a project must be reviewed continually to keep them current (reflecting a project continuum). An integrated approach must be implemented to ensure that there is a seamless progression of the cost estimate from systems (i.e. long-range) planning through priority programming and NEPA to the final engineer's estimate. This means that all costs should be included in all stages of an estimate, including the planning, programming, and NEPA stages. Since not all information is known in the early stages of a project, an adequate contingency is appropriate instead of actual costs for some items. The guidance discussed in the **Program Cost Estimate Elements** section is a comprehensive discussion of what should be included in an estimate.

Conceptual Estimates: Estimates during the planning/programming phases are usually conceptual in nature and can be prepared using estimating cost data that are based solely upon historic cost averages for projects with similar work scope and location characteristics, such as lane-mile (kilometer) cost averages for roadway work; or upon square-foot (meter) cost averages for bridge work. Additional costs or contingencies for work items such as utility work, mitigation work, and maintenance of traffic should also be included. This procedure should only be used for preliminary estimates and should include appropriate design contingency factors, based on an analysis of the project. At this point, it may be appropriate to attach a range to express the uncertainty of the estimate.

Statewide and MPO Transportation Improvement Programs: For planning/programming purposes, the timeframe in which a project will be implemented plays a key role in the level of precision of the project's initial cost estimate. For example, a project included in the first five years of the Metropolitan Planning Organization's (MPO's) long-range transportation plan should be based on more precise cost estimate information than a project reflected in the latter years of the MPO's long-range transportation plan. Precise cost estimating is even more important for a project contained in the MPO's Transportation Improvement Program (TIP) and/or the Statewide Transportation Improvement Program (STIP). Construction cost estimates for projects contained in the first two years of the STIP/TIP should be based on a high quality

estimates. This is especially important for non-attainment area where funding for the project must be available and committed.

Environmental Work: Although the intent of a project may be to avoid environmentally sensitive resources, some degree of environmental consideration and analysis is required for all major projects. If work associated with the alternative in the NEPA document is not included as part of the cost estimate, the NEPA document should note where the cost for the outstanding cost element could be found. For example, this could be short-term improvements that are already included in the Statewide Transportation Improvement Program (STIP). Any additional environmental avoidance, minimization, mitigation, remediation, and enhancement costs must also be included in the cost estimate. Costs to mitigate impacts to natural resources, cultural resources, neighborhoods, etc., must either be individually estimated or included in a contingency amount. Although large contingencies may be appropriate if no resource surveys have been conducted, resource surveys conducted as part of the NEPA process provide valuable information for refining cost estimates. Additionally, some major projects may have enhancement work that is not directly related to the project. This may include other transportation modes and non-transportation related work. These costs must be captured and included in the cost estimate. A major project that has a potentially significant effect or impacts on environmental resources or has opposition from environmental or community groups or regulatory agencies, tends to include more environmental mitigation which results in higher costs than those projects with relatively little impact or oppositions. Moreover, contingencies should be included for projects that include Intelligent Transportation System attributes, as well as in those States that are implementing Context Sensitive Strategies/Context Sensitive Design since very little historical data exists or is included in previous cost figures.

Estimating Risks: When preparing initial cost estimates during the NEPA process, all potential risks should be identified, analyzed, and quantified in the estimate. However, if this is not possible, because sufficient information is unavailable, a "worst-case" analysis may be appropriate to estimate costs. Existing facilities thought to be adequate may become inadequate because of changes to standards, new data, further deterioration prior to construction, etc. For example, full reconstruction of existing features, including structures, should be assumed, not rehabilitation. Structure lengths should assume spanning entire floodplains and wetlands. It may be appropriate to assume worst-case geotechnical conditions as a basis for design if there is limited information available. A worst-case scenario should only be used after analyzing the project and the available information carefully. Again, if there is considerable unknown information regarding the project, it may be suitable to attach a range to the cost estimate at this stage.

Coordination: NEPA cost estimates should be coordinated between Federal, State, and appropriate parties (e.g. Federal Transit Administration, MPOs, non-metropolitan local officials, local/regional transit service providers, and/or Native American Tribal Governments). Additionally, major adjustments to initial project/project phase cost estimates that result from the project development/NEPA processes should serve as an input for the next update of the pertinent MPO long-range transportation plan, metropolitan TIP, and/or the STIP.

When developing the program cost estimate at the PS&E stage, prior to the final Engineer's Estimate, the following should be considered:

Design Quantities: When determining the cost estimate in the PS&E stage, actual quantity take-offs should begin to be used approximately midway through the design stage or earlier. At this point the estimate should not be based entirely on preliminary estimating techniques. Therefore, it is extremely important that detailed project scoping information is available. There are two commonly used methods of preparing cost estimates based on quantity take-offs. One is bid based estimating and is based on historical data to estimate current costs. The other is cost based estimating and is determined by computing actual costs. Either method or a combination can be used to determine cost estimates.

Design Contingencies: Reasonable contingencies should be built into the total project cost estimate. Although not included in the final engineer's estimate a contingency based on different levels of design completion should be included in the project's total cost estimate. For example, at the beginning of the PS&E design stage; a design development contingency around 30% may be appropriate. As the actual design approaches 100%, the design development contingency should approach 0%. Contingencies for third-party and other unanticipated changes should also be considered. These contingencies may be developed based on previous historical data for similar type and size projects.

Final Engineer's Estimate: After all of the design has been completed, the contract documents have been prepared and all itemized quantities are available, a final engineer's estimate can be prepared. FHWA has issued technical guidance for final engineer's estimates called, "Guidelines on Preparing Engineer's Estimate, Bid Reviews and Evaluation" (http://www.fhwa.dot.gov/programadmin/contracts/ta508046.htm). However, this is only for the preparation of an engineer's estimate for the project letting. Some State Departments of Transportation (DOTs) refer to the final engineer's estimate as the letting estimate or the final certified DOT estimate. This estimate is used to permit an effective review and comparison of the bids received on the project.

QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance/Quality Control (QA/QC) must be part of the estimating process. Cost estimates must be reevaluated at significant milestones and tracked throughout the project. At least one independent Cost Estimate Review by a multi-disciplinary team should be conducted. The objective of the Cost Estimate Review is to verify the accuracy and reasonableness of cost estimates. Initial cost estimates (along with the future Initial Finance Plan estimate) will likely serve as a baseline in which any future project cost changes will be measured against.

Review Team: A multi-agency, multi-functional team that may consist of Federal, State, and consultant personnel should review the cost estimate to establish consensus. The team shall have a leader that is accomplished in the review of major project cost estimates ($1.0 billion range), including knowledge of how market conditions of major projects affect the total cost estimate. The team leader shall also be accomplished in the area of identifying various project risks, and in quantifying the risks as to potential dollar

value and likelihood of occurring, and identifying whether or not the current estimate is sufficient to cover these quantified risks. The team may include experts that are relevant to the engineering aspects of the project.

Project Scope. The team must be familiar with the project scope. The team will review all aspects of the cost estimate for accuracy and reasonableness and identify major cost items and estimate issues. At a minimum this would include structures, roadway elements, right-of-way, utilities, environmental mitigation, preliminary engineering, construction engineering, contract administration, contingencies, and inflation rates.

Project Risks: The review should document status of research, identification and ranking of risk factors and variability in the cost estimate. The team should then review and assign risk to individual scope items. Then the team should document comments, risk factors, and computation of the revised estimate.

ATTACHMENT A

Washington State Department of Transportation's Cost Estimate Validation Process (CEVP™): CEVP™ is a tool used by Washington State Department of Transportation to evaluate the quality and completeness of the estimate. It is intended to assist in developing a higher level of confidence in the estimate and to identify major areas of variability and uncertainty in the defined project that significantly influence the cost estimate. CEVP™ assigns a range of dollar amounts to project risks. The revised estimates are stated in dollar ranges, not as single numbers. This reflects the limits of estimating precision at the planning stage where crucial decisions are yet to be made and specific risks cannot be exactly costed. Usually, this occurs between the 5% and 30% design phase. More information can be found at the Washington Department of Transportation's website (http://www.wsdot.wa.gov/projects/cevp/).

ATTACHMENT B - CHECKLIST: How have the following factors been considered during the preparation of the cost estimate? Identify critical issues and risks.

COST ITEM	**ESTIMATED COST**	**CRITICAL ISSUES AND RISKS**
Preliminary Engineering		
Right-of-Way		
Construction Cost		
Contracting Technique		
Surety		
Economic Impact		
Competition		
Wrap up Insurance		
Specialized Technology		
Material Availability		
Construction Time		
Construction Incentives		
Protection of the Traveling Public		
Design Progression		
Construction Administration		
Construction Contingencies		
Environmental Document Preparation		
Environmental Mitigations/Enhancements		
Utility Adjustments		
Railroad and Transit Adjustments		
Public Outreach		
Management Reserve		
Cost Escalation		
ITS		
Aesthetic Treatments/CSD		

Other cost items should be added depending on the project's characteristics.